Title of the Invention

1. Please replace the Title of the Invention with the following amended Title:

   ~~KD~~ QKD Systems with Robust Timing

In the Specification

1. Please replace paragraph [0003] with the following amended paragraph [0003]:

[0003] Quantum key distribution (QKD) involves establishing a key between a sender ("Alice") and a receiver ("Bob") by using weak (e.g., 0.1 photon, on average) optical signals transmitted over a "quantum channel." The security of the key distribution is based on the quantum mechanical ~~principal~~ <u>principle</u> that any measurement of a quantum system in an unknown state will modify its state. As a consequence, an eavesdropper ("Eve") that attempts to intercept or otherwise measure the quantum signal will inherently introduce errors into the transmitted signals, thereby revealing her presence.

2. Please replace paragraph [0005] with the following amended paragraph [0005]:

[0005] The Bennett-Brassard article and the '410 patent each describe a so-called "one-way" QKD system wherein Alice randomly encodes the polarization of single photons, and Bob randomly measures the polarization of the photons. The one-way system described in the '410 patent is based on a two-part optical fiber Mach-Zehnder interferometer. Respective parts of the interferometer are accessible by Alice and Bob so that each can control the phase of the interferometer. The signals (pulses) sent from Alice to Bob are time-multiplexed and follow different paths. The '410 patent discloses a separate "timing channel" to convey timing signals from a sender to a receiver. However, the timing systems and methods necessary for practical operation <u>of</u> the system are not disclosed in the '410 patent.

3. Please replace paragraph [0018] with the following amended paragraph [0018]:

[0018] FIG. 3A is a schematic diagram of the optical modems of the timing system of FIG. 1A, wherein each optical modem has optical circulator, an optical transmitter, an

optical receiver and associated phase lock loops, and illustrating the connections between the receive ~~time~~ timing domains (RTDs) and the transmit ~~time~~ timing domains (TTDs), as well as the sync signals that travel in each direction over the timing channel connecting the modems;

4. Please replace paragraph [0023] with the following amended paragraph [0023]:

[0023] FIG. 5A is a schematic diagram of a clock-based digital pulse generator (DPG) implemented in the field-programmable gate array (FPGA) ~~FPGA~~ of the controller as used to generate trigger pulses for the drivers;

5. Please replace paragraph [0025] with the following amended paragraph [0025]:

[0025] FIG. 6 is a schematic diagram of an example embodiment of a random-number-generator (RNG) ~~an RNG~~ unit that includes multiple data sources and a data source selector coupled to a modulator driver;

6. Please replace paragraph [0082] with the following amended paragraph [0082]:

[0082] With reference to FIG. 3A, system 70 includes at Alice a circulator 204B coupled at one port to an optical transmitter 200A and at another port to an optical receiver 202A. Optical receiver 202A is coupled to a receive PLL 216A-2, which is coupled to the receive ~~time~~ timing domain RTD. Optical transmitter 200A is coupled to a fixed clock oscillator ("transmit OSC") 216A-1.

7. Please replace paragraph [0083] with the following amended paragraph [0083]:

[0083] Likewise, system 70 includes at Bob an arrangement similar to that at Alice describe immediately above, but with a circulator 204B, optical transmitter 200B, an

optical receiver 202B, ~~an~~ a transmit PLL 216B-1 and a receive PLL 216B-2. Note that at Bob the optical receiver 202B is coupled to both the receive PLL 216B-2 and the transmit PLL 216B-1.

8. Please replace paragraph [0086] with the following amended paragraph [0086]:

[0086] Control signals from Alice to Bob are extracted from the detected sync signal S3 of the optical receiver 202B and are synchronized to the receive ~~time~~ timing domain (RTD) of Bob.

9. Please replace paragraph [0087] with the following amended paragraph [0087]:

[0087] The receive PLL 216B-2 and transmit PLL 216B-1 recover the signal from optical receiver 202B, and in effect make a locked copy of the receive timing domain RTD and transmit ~~time~~ timing domain (TTD) on Bob that is synchronized to the TTD on Alice.

10. Please replace paragraph [0102] with the following amended paragraph [0102]:

[0102] In operation, for the RTD, phase comparator 600 measures the phase difference between two clock signals from receiver 202 and produces a voltage proportional to the input phase difference. One ~~the~~ clock signal input is always in the RTD, namely the fed back output from the RTD VCO 604. The other clock signal can be selected by switch SW1 that connects phase comparator 600 to either optical receiver 202 at "A" or phase comparator 601 at "B" so that the phase comparator 600 measures the RTD clock versus the input from the optical receiver or measures the

RTD clock versus the TTD clock.

11. Please replace paragraph [0107] with the following amended paragraph [0107]:

[0107] For the TTD, phase comparator 601 measures the phase difference between two clock signals and produces a voltage proportional to the input phase difference. One clock signal input is always in the TTD, namely the fed back output from the TTD VCO 605. The other clock signal is always input from the optical receiver 202.

12. Please replace paragraph [0116] with the following amended paragraph [0116]:

[0116] FIG. 4 shows the series of sync pulses P3 that make up optical sync signal S3. In an example embodiment, the leading edges of the pulses stay on a regular time interval ~~Toclk~~ "T opt clock" (abbreviated below as "Toclk") nominally in the 10 ns to 50 ns range, while the width ~~w~~ (w) of the pulses is used to encode data. An example of encoded data is where the pulse width that defines a logical 0 or 1 identifies the signal sender as Bob or Alice (i.e., authentication). Sufficient bandwidth is available to transmit the pulses of varying width such that the pulse width w can be detected at the receiver.